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ABSTRACT

This paper examines the possibility of developing a conceptual framework on which future research on the application of electroencephalography (EEG) to computer-assisted instruction (CAI) could be based. Consistent associations between EEG and cognitive functions for learning and instruction have the potential for bringing cognitivism into the realm of behaviorism, i.e., electrical brain activity could be behavioral evidence of cognition. These associations would be based on the possibility of detecting and responding to the internal conditions of learning via EEG in such a way that instructional design would become a technology. A comprehensive scientific theory of learning and instruction would be developed based on identification and testing of all of the instructional variables, and based on physiological evidence, scientifically proven cognitive models, and empirical evidence from instructional environments. However, while the potential for such a theory exists, the reality of it remains unknown, and educators must, to some degree, continue the craft of quilting together the theories and variables of learning and instruction as new evidence is revealed, rather than attempting to construct "comprehensive" theories that are not empirically based. (4 references) (EW)

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Abstract

The purpose of this study was to develop a conceptual framework on which future research on the application of electroencephalography (EEG) to computer assisted instruction (CAI) could be based. I hoped to uncover EEG research that supported consistent associations between EEG and cognitive functions. The consistent associations could then have been integrated with the current state of learning and instructional design theories to develop a conceptual framework that directly translated into research on the application of EEG to CAI.

The implication of consistent associations between EEG and cognitive functions for learning and instruction is the potential to bring cognitivism into the realm of behaviorism. In other words, the electrical brain activity could be, in essence, behavioral evidence of cognition. This behavioral evidence need not travel from the brain through the muscles to the input device of the computer, but could be received by the computer through a more direct interface. Therefore, the possibility of altering the representation of the original cognitive function could be minimized. Theoretically, such an interface could improve the effectiveness of instruction by adjusting the CAI according to the EEG information.

Unfortunately, associations between EEG and cognitive functions have not reached a level of consistency to make the development of such a highly refined conceptual framework possible. The conceptual framework that does result from this research, albeit somewhat less refined than hoped for,

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considers the potential integration of the four areas studied--learning theory, instructional design theory, CAI and EEG. The research in these areas, independently and collectively, has a potential for synergistic development of all of the areas.

Epilogue

One purpose of education is the management of the environment to optimize learning (Chipman, 1986). This is accomplished through instructional planning and design. Ideally, an instructional design theory would create a generalizable model of instruction that integrates efficacious instructional strategies with the conditions of learning to optimize instructional outcomes.

Heinich (1985) viewed instructional design as a technology that, through increasing sophistication will incorporate "more and more operational actions into the design stages, reducing the necessity for ad hoc decisions at the point of use" (p. 11). Ad hoc decisions, according to Heinich, were characteristic of the traditional "craft" of instructional planning, typical of classroom instruction.

In one respect Heinich's (1985) proposal is attractive because it carries with it the concept that if instructional design was a technology rather than a craft, the inputs and outputs of instruction would be predefinable variables. Instruction, in effect, would be a closed system; once variables were defined and instruction designed accordingly, outcomes could be nothing but successful. This is probably an oversimplified view, but nonetheless, Heinich hints at this ultimate possibility.

A major limitation of the advancement of the technology of instruction, according to Heinich (1985) was the structure of current educational systems. He cited instances in which policy-makers were unwilling or unable to adjust the system to accommodate new and effective instructional methods. My study, however, while recognizing such a limitation exists, has approached

instructional design not from a policy-maker's perspective, but from the practitioner's perspective.

The premise of this study was that if CAI could receive information directly from the source of learning--the brain--then perhaps the CAI could be designed to adjust to previously unobservable internal conditions accordingly. The question about the techonology of instruction at this level is: Is it possible to detect and respond to the internal conditions of learning via EEG to the point that instructional design can be a technology? Unfortunately, the associations between EEG and cognitive functions are not unequivocally established. Therefore, the application of EEG to instructional design will not yield a technology of instruction.

Research on EEG and cognition has advanced tremendously over the past quarter century and the results have revealed information that has, in some cases, supported hypotheses of the cognitive activity involved in learning (Languis, 1985). Tapping into this cognitive activity via an EEG interface during CAI is constrained by a number of limitations discussed in the full report of my study. The past 30 years saw the birth and development of instructional design as a discipline (Reigeluth, 1983). Instructional design theories advanced partially as a result of a greater understanding of cognition and partially because of environments in which instructional variables could be controlled and manipulated, such as in CAI. The application of scientific inquiry to each of these areas has contributed immensely to the advances, because it is through scientific inquiry that hypotheses are tested and accepted, rejected, or modified for further testing. Paths that hold potential can be investigated; superfluous paths can be abandoned without further time and money expenditures.

A comprehensive scientific theory of learning and instruction will only become a reality if all the variables are identified and defined. There is little doubt at this time that these variables are countless and complex. Each step

of scientific inquiry, though, has the potential to lead in the direction of a comprehensive theory.

In the history of learning and instructional theory, behaviorism set the stage for the scientific approach through the demands for empiricism made by its advocates. Cognitivism postulated, and continues to postulate models of the unobservable. Physiologists use scientific methods to support or suppress these models. Instructional designers attempt to integrate the theories and models into efficacious learning environments. A setting such as the application of EEG to CAI has the potential to test these models and theories in a controlled learning environment. All of the areas have the potential to synergistically effect the development of a comprehensive learning theory.

While the potential for a comprehensive theory of learning exists--one that is based on physiological evidence, scientifically proven cognitive models, and empirical evidence from instructional environments--the reality of such a theory remains unknown. Heinich's (1985) technology of instruction might exist for micro instructional frameworks, such as an isolated drill and practice or tutorial lesson, but at the macro level, the variables are often too complex to control. Therefore, educators must, to some degree, continue the craft of quilting together the theories and variables of learning and instruction.

There have been unfortunate instances in education, when educators, driven by the anxiety to sew up the gap between the technology and craft of education, have grasped a single thread of empirical evidence of learning and attempted a weave an entire theory of learning and instruction from the single thread. There is hope that a comprehensive theory is possible. There is hope that the application of EEG to CAI can contribute valuable information that will help weave such a theory. But, unfortunately, a golden thread does

not yet exist. For educators today it is best to parade in the current patchwork quilt of learning theory and instructional design theory, adding, deleting, and mending as new evidence is revealed, than to strut the streets in the emperor's clothing of non-empirical "comprehensive" theories.

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